

Multi criteria decision analysis (MCDA) of land-use using sentinel-2 imaginary as a proxy to predict nutrient inputs into a reservoir cascade system

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Abstract

With the emerging anthropogenic activities, the excess nutrient levels within reservoirs may become a threat to the balance of aquatic ecosystem leading to drastic changes. This study was done to investigate whether there would be any correlation between Land use/Landcover (LULC) patterns and the reservoir nutrient distribution within a cascade system because, the tank cascade system acts as a water purification center within the catchment. Thirappane Cascade System (TCS) which is located in Anuradapura district was selected as the study area. The LULC map was generated using a sentinel-2A image with a resolution of 10m and maximum likelihood classification method. Five categories of LULC patterns (water body, forest cover, chena cultivation, barren lands, build up areas) were used for the classification and the kappa statistical method was used to determine the accuracy level (kappa statistic= 0.83). Surface water samples from the reservoirs and soil samples from the relevant catchment areas were collected by considering the LULC pattern. Water and soil quality parameters that can be affected generating nutrient hotspots were measured. Nutrient hotspot maps for relevant catchment areas and nutrient distribution maps for six reservoirs were created using Multi Criteria Decision Analysis (MCDA) method and Inverse Distance Method (IDW) in QGIS software. LULC areas near Meegasgama, Alisthana and Bulankualama reservoirs had high nutrient hotspots than the other LULC areas in this cascade system. Reservoir nutrient level also was very high when compared to other reservoirs. Total phosphorus level varied from 0.08 ± 0.02 mg/L to 0.43 ± 0.11 mg/L ($p < 0.05$) and total nitrogen level varies from 3.40 ± 0.97 mg/L to 11.38 ± 0.73 mg/L ($p < 0.05$) within the cascade system. The developed model concluded that a high amount of nutrient was accumulated in Meegasgama, Alisthana and Bulankulama reservoirs and finally purified water was delivered to the Thirappane reservoir. Hence, Meegasgama, Alisthana and Bulankulama areas act as nutrient barriers and accumulate high amounts of nutrient within the reservoirs as well as within the relevant catchment areas. Furthermore, water quality in the cascade system had been significantly influenced by the LULC pattern of the catchment areas. Similar studies can be used to plan the LULC pattern of a reservoir cascade system for improving the sustainable management of those aquatic environments.

Keywords

Reservoir cascade system, land use/land cover, nutrient hotspots, multi criteria decision analysis

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